

THE WEATHER AND CIRCULATION OF OCTOBER 1951¹

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The 700-mb. circulation pattern for the month of October (fig. 1) shows a fairly flat westerly flow dominating the weather of the United States. There were four weak troughs in the country or nearby: 1. off the Atlantic Coast, 2. from southern Nevada south-southwestward, 3. from Colorado northeastward to Lake Superior, and 4. across the Washington-Oregon border. Height departures from normal were rather weak with a negative center over the Pacific Northwest and a stronger positive center over New England. The most conspicuous feature

affecting North America was the ridge over the Yukon Territory, tilted northwestward at higher latitudes to a positive anomaly center over Alaska. The fast westerlies of the eastern Pacific and the marked diffluence over the western United States suggest that the trough over the Great Plains was typical of the type formed to the lee of the Rocky Mountains.

The European weather and circulation were sufficiently anomalous to warrant some mention in this résumé. Figure 1 shows that the largest positive height anomaly in the northern hemisphere (+450 ft.) was centered over southern Scandinavia, just north of a strong (10,200 ft.) warm

¹ See Charts I-XV following page 204 for analyzed climatological data for the month.

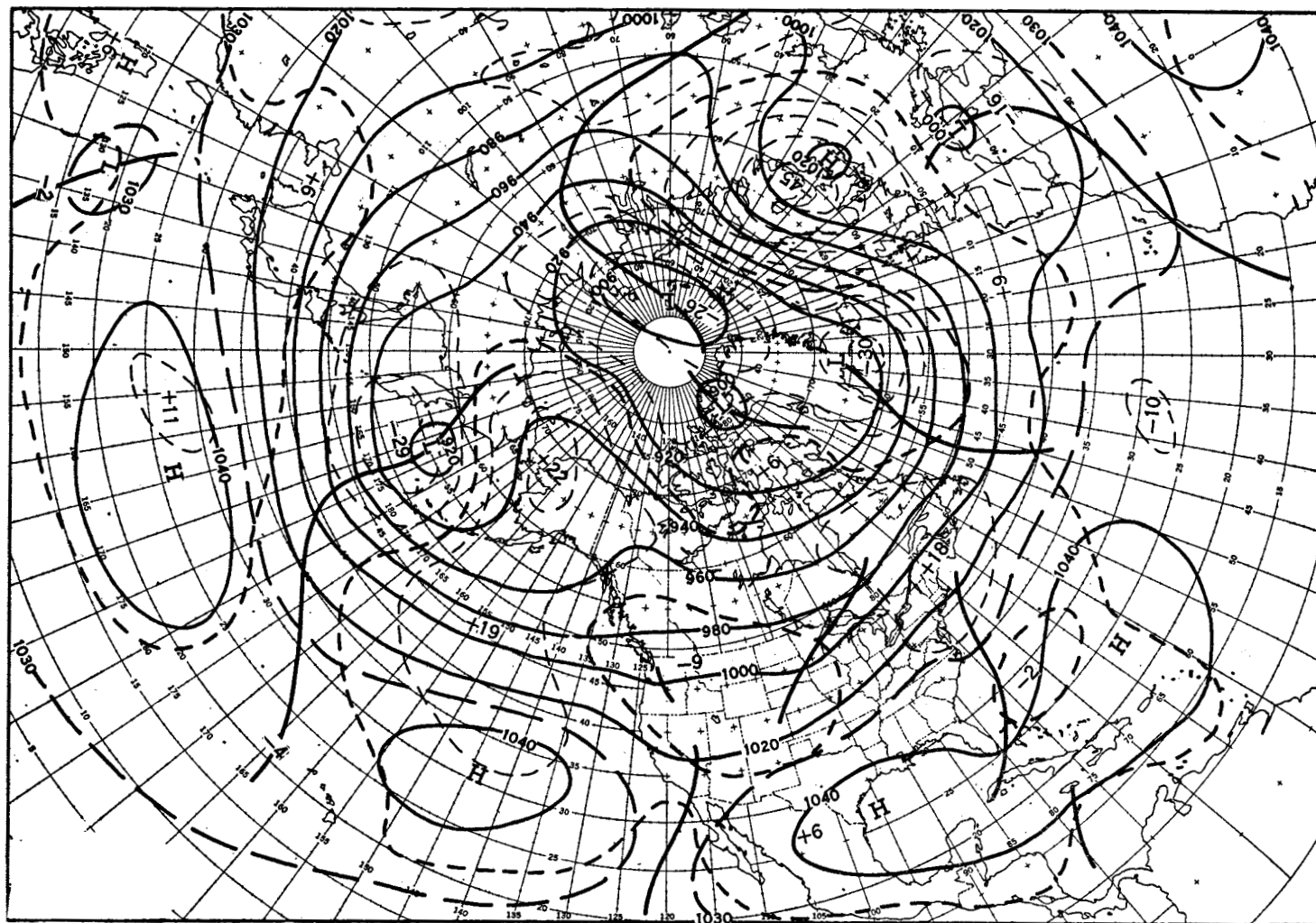


FIGURE 1.—Mean 700-mb. chart for the 30-day period October 1-31, 1951. Contours at 200-foot intervals are shown by solid lines, intermediate contours by lines with long dashes and 700-mb. height departures from normal at 100-foot intervals by lines with short dashes with the zero isopleth heavier. Anomaly centers and contours are labeled in tens of feet. Minimum latitude trough locations are shown by heavy solid lines.

anticyclone of the blocking type over the Baltic Sea. This High first appeared during the last week of September and persisted with minor oscillations until the week of October 17-24, when it temporarily disappeared, only to return and again dominate the region during the last week of October. The fine weather enjoyed by northern and central Europe under this anticyclonic regime was in sharp contrast to that experienced over the Mediterranean. Such a block of the mid-latitude westerlies characteristically diverts storms to the north and south of the warm High. In this case the diverted cyclonic activity to the south and the secondary storms generated *in situ* gave rise to damaging gales, heavy rains, and local floods in the central Mediterranean, where a cold closed Low (10,000 ft.) was centered at 700 mb. It is noteworthy that the European circulation and weather during this month resembled that of the "Atlantic block" described by Rex [1].

The center of cyclonic activity in the Pacific was located near the western Aleutians, with the upper level trough (fig. 1) tilting southeastward toward the Hawaiian Islands. Thus the Aleutian Low was much farther west than in September [2], although the major shift of this center of action did not occur until the latter half of October. The 700-mb. five-day mean map for October 27-31, 1951 (fig. 2) is fairly representative of the circulation during the second half of October. The intense Aleutian Low and the deep trough west of the Hawaiian Islands combined to produce a strong warm High in the eastern Pacific. This pattern was intense enough to dominate the monthly mean, although the early period activity favored a Gulf of Alaska Low and a stronger West Coast trough. The Pacific westerlies were quite strong at middle latitudes, and numerous storms traversed the Pacific just north of the belt of maximum westerlies. The concentration of cyclonic activity in the Aleutians and Gulf of Alaska (Chart X) was closely associated with strong cyclonic shear at 700 mb. (fig. 1) and a pronounced trough at sea level (Chart XI).

As might be inferred from the poor definition of the trough and ridge features over the United States shown in figure 1, the major cyclonic developments were neither geographically concentrated nor of exceptional intensity (Chart X). Several storms from the Gulf of Alaska entered the west coast between 45° and 55° N. latitude. These storms usually travelled southeastward after they crossed the Continental Divide, recurved near the mean trough over the Great Plains, and then swept northeastward through the western Lakes. Following the passage of these cyclones numerous secondaries formed on trailing cold fronts in the Rocky Mountain States or Western Plains in the eastern part of the area of below-normal 700-mb. heights.² Four storms appeared during the month

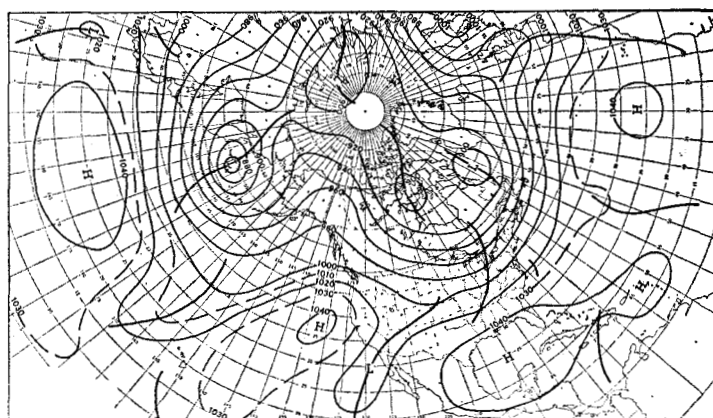


FIGURE 2.—Mean 700-mb. chart for the 5-day period October 27-31, 1951. Contours at 200-foot intervals are shown by solid lines, intermediate contours by dashed lines, and minimum latitude trough locations by heavy solid lines. Contours are labeled in tens of feet.

in the Southwest and contributed to below-normal heights and a low latitude trough there on the mean. A few storms moved northeastward off the east coast of the United States in the trough at sea level and aloft. The steep profile of this trough at lower latitudes reflected in part the early period hurricane which passed over southern Florida and moved northeastward, and the tropical storm of mid-period which stalled north of the Bahamas for five days (Oct. 15-19). In general, cyclones which crossed North America during October were quite widely scattered latitudinally, as can be inferred from the lack of a well marked zone of strong cyclonic shear in figure 1. However, most of them deepened as they sped eastward and many reached their maximum depth in the vicinity of the mean trough between Greenland and Iceland. This area was the seat of persistent cyclonic activity which led to below-normal heights at 700 mb. (fig. 1) and below-normal pressures at sea level (Chart XI, inset). The most intense storm was that of October 14 which deepened to a sea level pressure of 955 mb.

The anticyclone tracks (Chart IX) showed even poorer definition in the sense that no preferred path was evidenced. However, the mean sea level map (Chart XI) indicated the general prevalence of anticyclonic circulations over the Appalachians and northwestern Canada. These areas were characterized at 700 mb. by positive height anomalies and anticyclonic shear and curvature. The lack of cyclonic activity in these regions is indicated by Chart X.

The mean surface temperatures and their anomalies over the United States (Chart I, A and B) show that cool air dominated the northwestern quarter of the country except for the Pacific Coastal region. Greatest negative departures were -5° F. in central Montana. Below-normal temperatures prevailed rather uniformly over that area where 700-mb. heights were below normal

² A study, by J. A. Carr, of one of these occluding cyclones appears in an adjacent article [3].

and the flow was west-northwesterly behind the trough, despite the relative weakness of these features. Low temperatures in this region were caused partly by cool maritime air from the Pacific and partly by colder continental air moving southeastward from the Alaska-Yukon area behind the cyclones as they traveled eastward. This tendency for cold Highs to penetrate southeastward became more pronounced as the period progressed. Comparison of figures 1 and 2 indicates that, during the last five days of the month, the ridge in Alaska and the eastern Pacific was considerably stronger and the United States trough considerably deeper than indicated by the monthly mean. Between these features a strong and extensive flow of air with a long fetch from the northwest was established. Under this circulation a massive cold air outbreak was spreading southward and southeastward over the whole United States as the month came to an end.

The eastern half of the country enjoyed generally above-normal temperatures throughout the month (except for a brief cold spell from Oct. 10-14) under west-southwesterly flow and above-normal heights at 700 mb. Daily maximum temperature records of 90° were established at Chicago, Ft. Wayne, and Indianapolis, and of 96° at Macon, Ga. and Jacksonville, Fla. The positive temperature departures diminished farther south so that extreme southern Florida experienced near normal temperatures under the cyclonic northwesterly flow aloft. The warm weather of summer and early fall continued in Texas as strong westerlies in the eastern Pacific and the Nevada trough combined to protect that area from cold air invasions. In addition, above-normal heights and anticyclonic circulation aloft provided ample opportunity for abundant sunshine (Chart VII-B). New record daily maximum temperatures of 100° at Ft. Worth, 106° at Dallas, and 102° at Del Rio were recorded. The largest (+6° F.) monthly mean temperature anomalies in the entire country were observed in the area west of the Pecos, where the southwesterly fetch aloft was most pronounced. To a lesser extent the far Southwest was similarly warm except for occasional invasions by cool Pacific and Continental air masses following the low latitude storms which affected the area. This activity intensified during the last week of the month as heights rose in the eastern Pacific and a deep trough brought weekly temperatures in southwestern Nevada to as much as 6° below normal. The over-all temperature pattern in the United States was fairly similar to that of September, a pattern which has been common during the past year [2].

The most striking feature of the precipitation totals and anomalies (Charts II and III) is the excessive precipitation in the Pacific Northwest. State averages of 209 percent and 298 percent of normal for Washington and Oregon, respectively, provided ample moisture for the northwestern hydroelectric installations. Abundant precipitation in this area was intimately related to the

presence of a center of negative height anomaly at 700 mb., fast westerly flow impinging from the Pacific, the proximity of the principal storm path, and strong cyclonic shear aloft [4]. The trough in the Southwest was located east of the normal trough position off the west coast. It was conducive to the weak extension of the northwestern precipitation toward Southern Nevada but was most effective in the production of precipitation over Arizona, Utah, and western New Mexico, where perennial water shortages make almost any precipitation welcome. There was, in addition, considerable precipitation over the central Rocky Mountain States, mainly on the cold air side of the boundary between above- and below-normal temperatures. This precipitation resulted from cyclonic activity in a broad trough aloft, low level upslope effects, and overrunning of cold air from the west and southwest. This overrunning is well indicated by contrasting stronger than normal easterly flow at sea level (Chart XI and inset) with stronger than normal westerly flow aloft (fig. 1). The area of heavy precipitation extended eastward from Colorado and Wyoming to the central Mississippi Valley in a zone of confluence at 700 mb. between warm southwesterly and cool northwesterly flows. There it merged with a conspicuous precipitation area in and east of the trough over the Great Plains. Frequent cyclonic activity was associated with this trough. Of these storms, those which were at lower latitudes and more intense drew directly upon the Gulf of Mexico as a source of moisture. As a result precipitation was abundant in most of the Mississippi Valley.

The state-wide precipitation averages of the Eastern States were all below normal except for New England, New Jersey, and Florida. This dry weather was related to anticyclonic conditions at sea level and aloft and to diffuence of the upper level contours. Precipitation exceeded normal only in extreme coastal sectors, which were affected by tropical and wave disturbances moving up the trough along the Atlantic Coast. For inland areas of the Southeast the October precipitation deficit, together with the cumulative effect of similar shortages in earlier months, retarded crop growth and further damaged pasture conditions. The driest weather was noted in South Carolina where only 39 percent of normal precipitation was recorded. However, the dry spell provided excellent harvesting weather for this and adjacent areas.

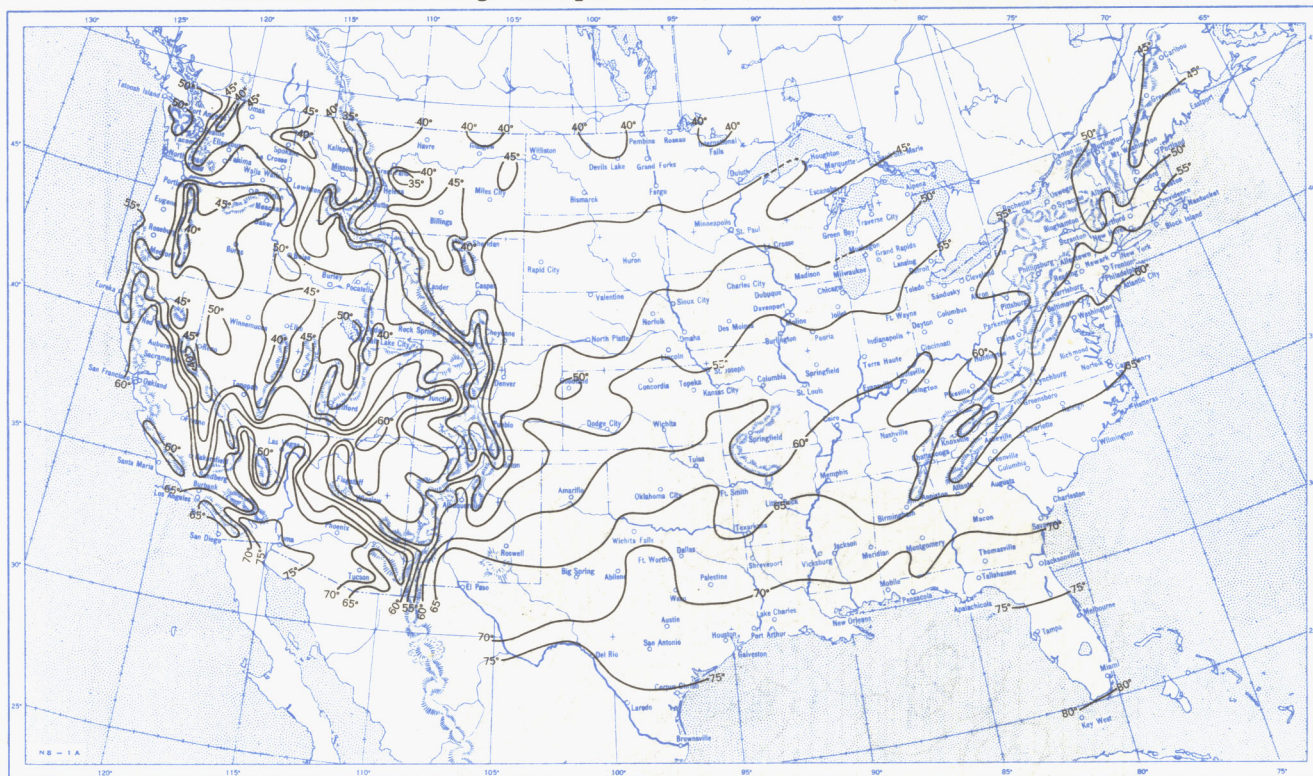
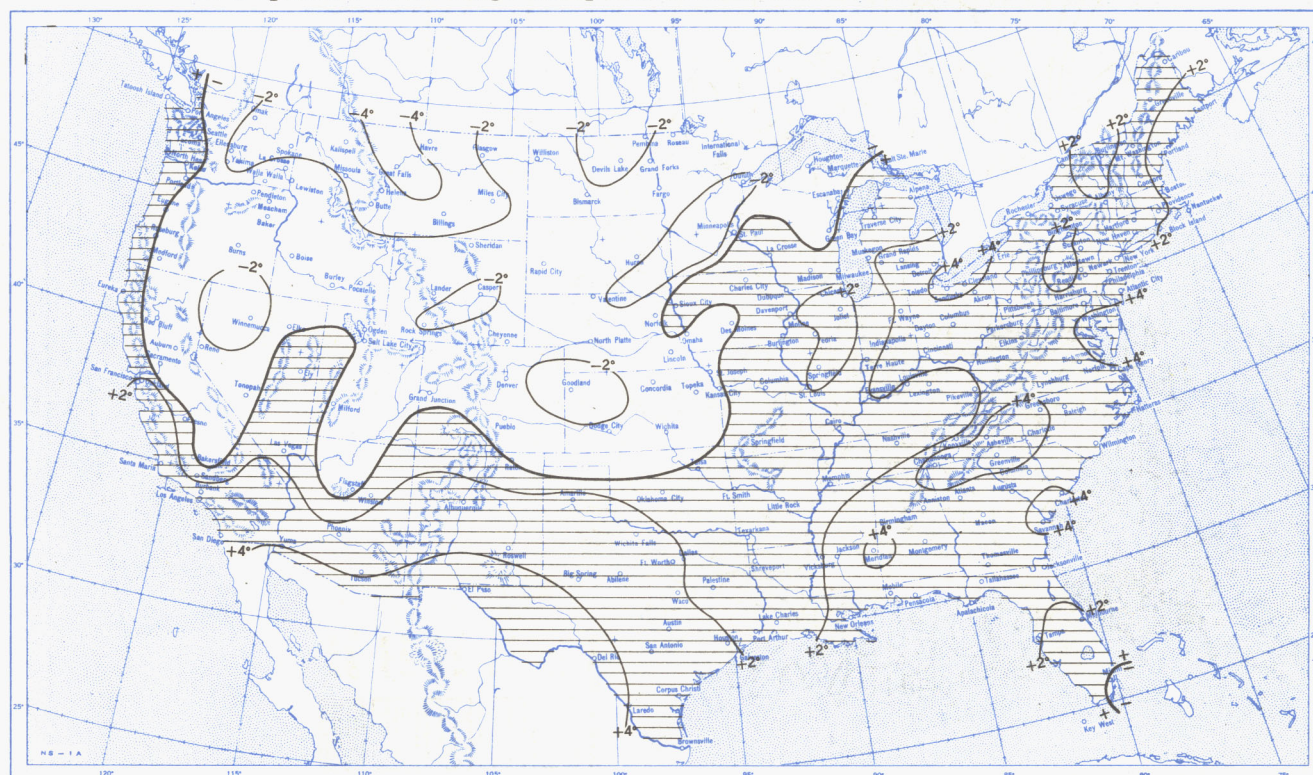
As the cold air from Canada entered the United States farther west than in most recent months, Iowa enjoyed a month of above-normal temperature, with a southerly flow component (relative to normal) at sea level and aloft. Less fortunate was its position in a confluence zone just east of the mean trough at 700 mb. This position is quite conducive to precipitation, and a State average of 136 percent of normal was recorded. This was unfortunate after a cold, wet growing season. The result was only slow growth and maturation of the late corn crop

during early October. In addition, harvesting and storage were seriously delayed by the wet, cloudy weather and the continued high moisture content of the corn itself. The early freeze of September [2] and the continued moisture had greatly reduced quality, so that estimates of equivalent yield have been sizably reduced.

The anomalous intensity of the Hawaiian trough is one of the more significant features of figure 2. This trough intensified as the 700-mb. Pacific High split just to the west of Hawaii and cold air from higher latitudes was advected into the tropical area. The resulting cyclogenesis and convergence brought the first Kona storm of the season and widespread heavy precipitation even to those parts of the islands usually sheltered from the almost daily precipitation caused by orographic lifting of the prevailing northeasterly trades.

REFERENCES

1. D. F. Rex, "The Effect of Atlantic Blocking Action Upon European Climate," *Tellus*, vol. 3, No. 2, May 1951, pp. 100-111.
2. H. F. Hawkins, Jr., "The Weather and Circulation of September 1951," *Monthly Weather Review*, vol. 79, No. 9, September 1951, pp. 179-182.
3. J. A. Carr, "An Occluding Wave, October 7, 1951," *Monthly Weather Review*, vol. 79, No. 10, October 1951, pp. 200-204.
4. D. E. Martin and H. F. Hawkins, Jr., "The Relationship of Temperature and Precipitation over the United States to the Circulation Aloft," *Weatherwise*, vol. 3, No. 6, December 1950, pp. 138-141.

Chart I. A. Average Temperature ($^{\circ}\text{F.}$) at Surface, October 1951.**B. Departure of Average Temperature from Normal ($^{\circ}\text{F.}$), October 1951.**

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

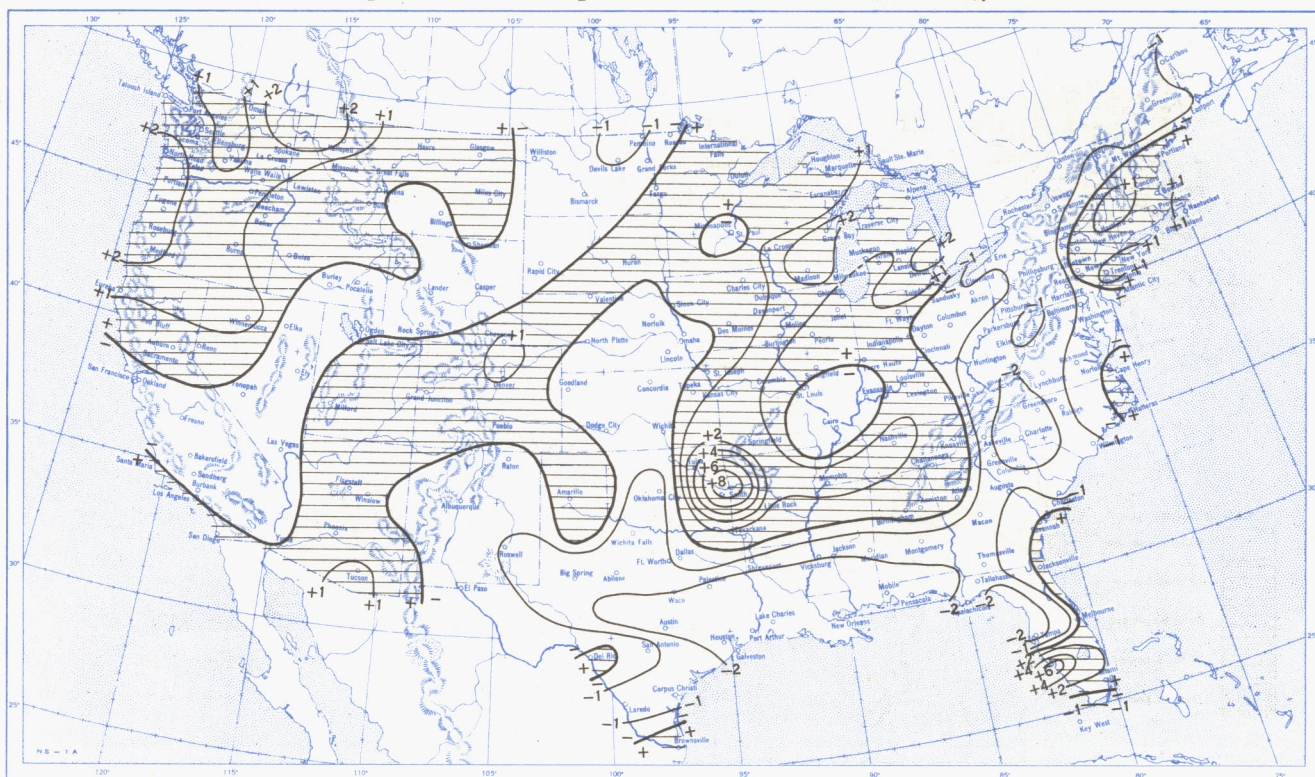
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), October 1951.

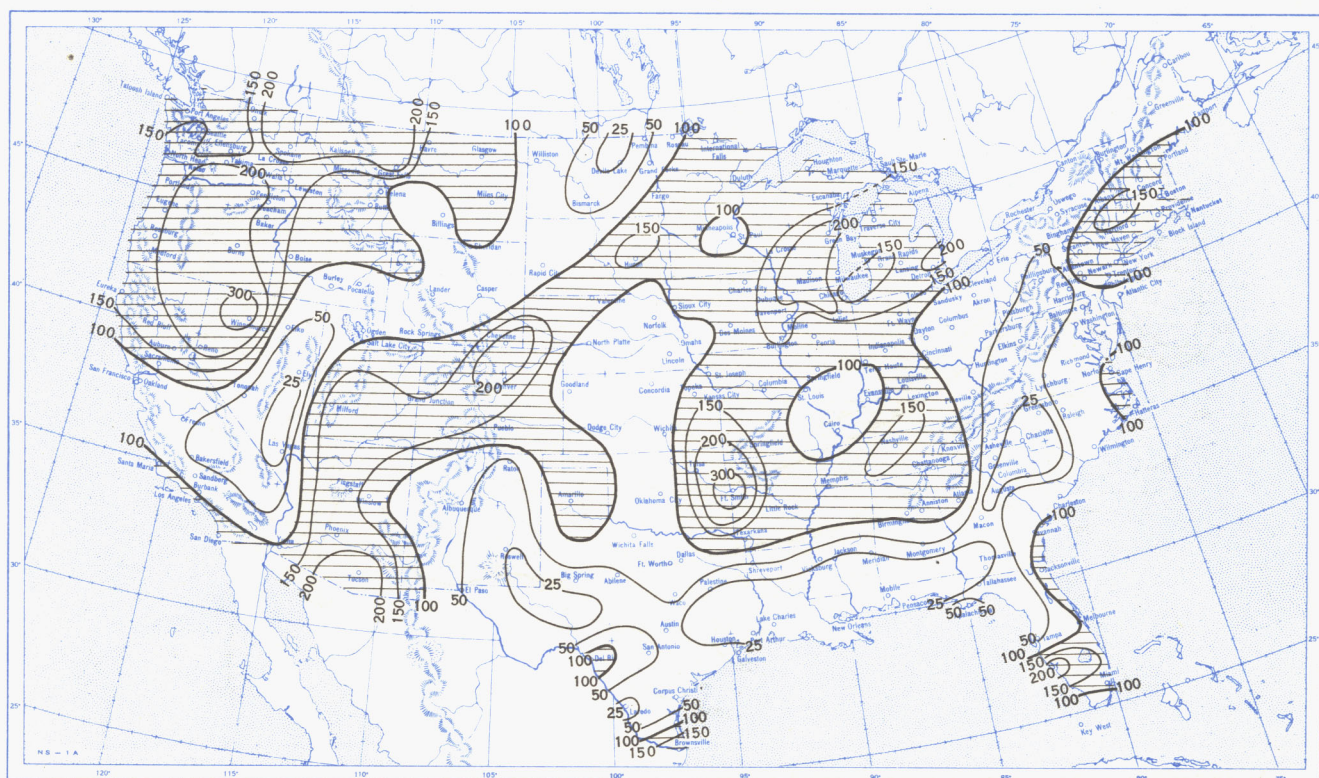


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), October 1951.

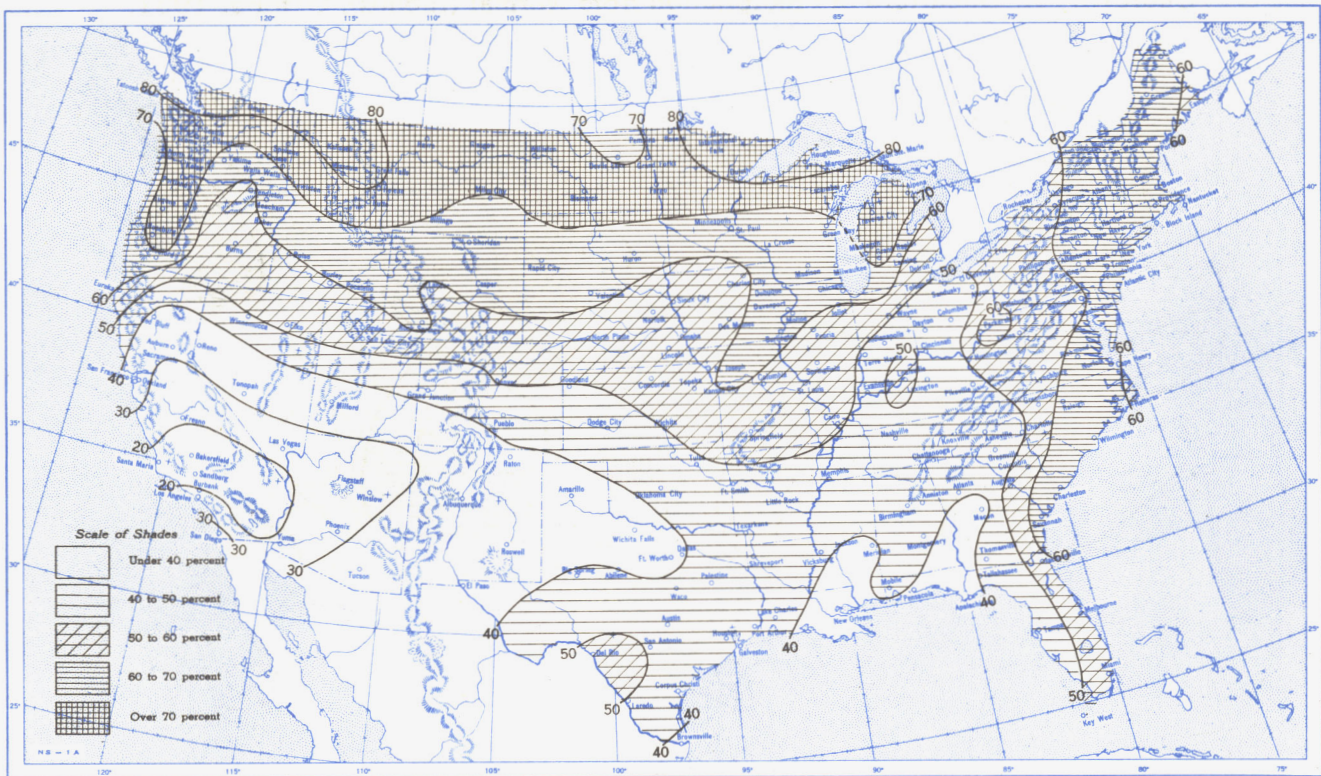


B. Percentage of Normal Precipitation, October 1951.

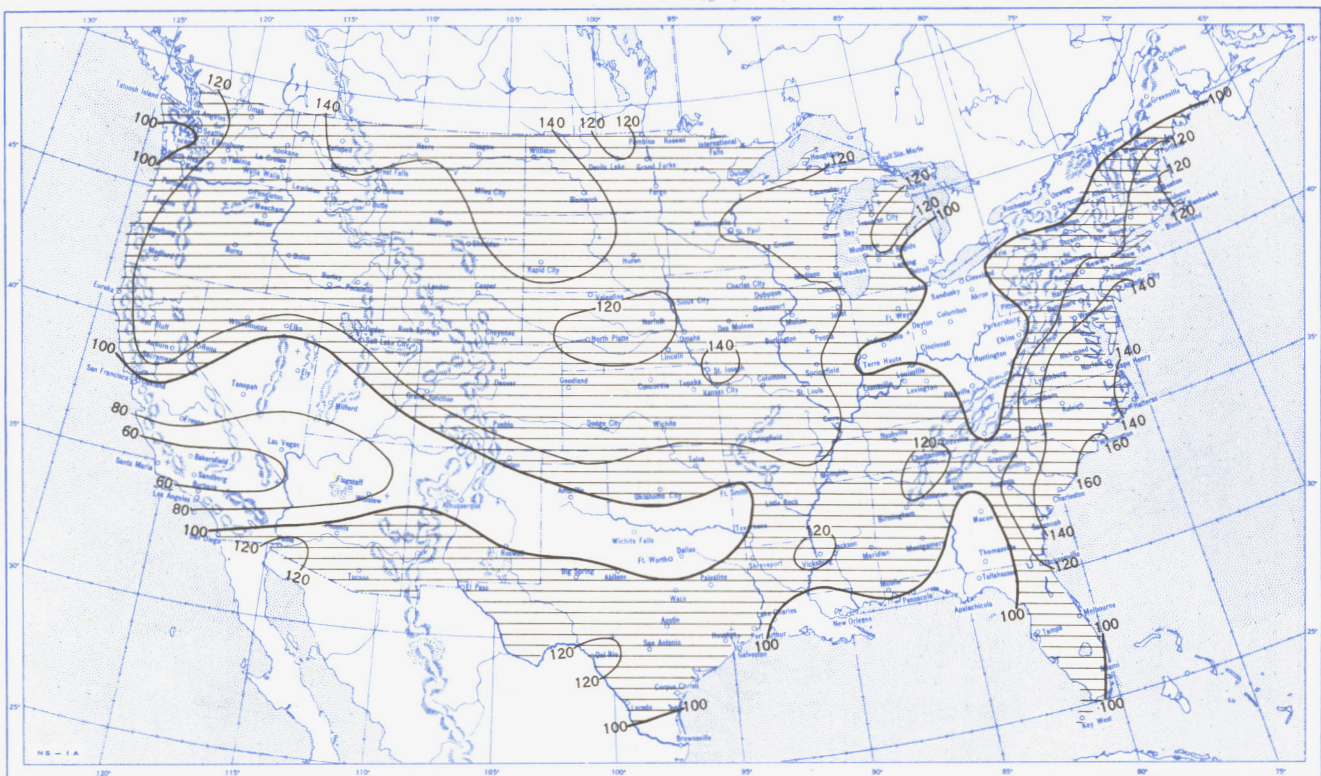


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, October 1951.

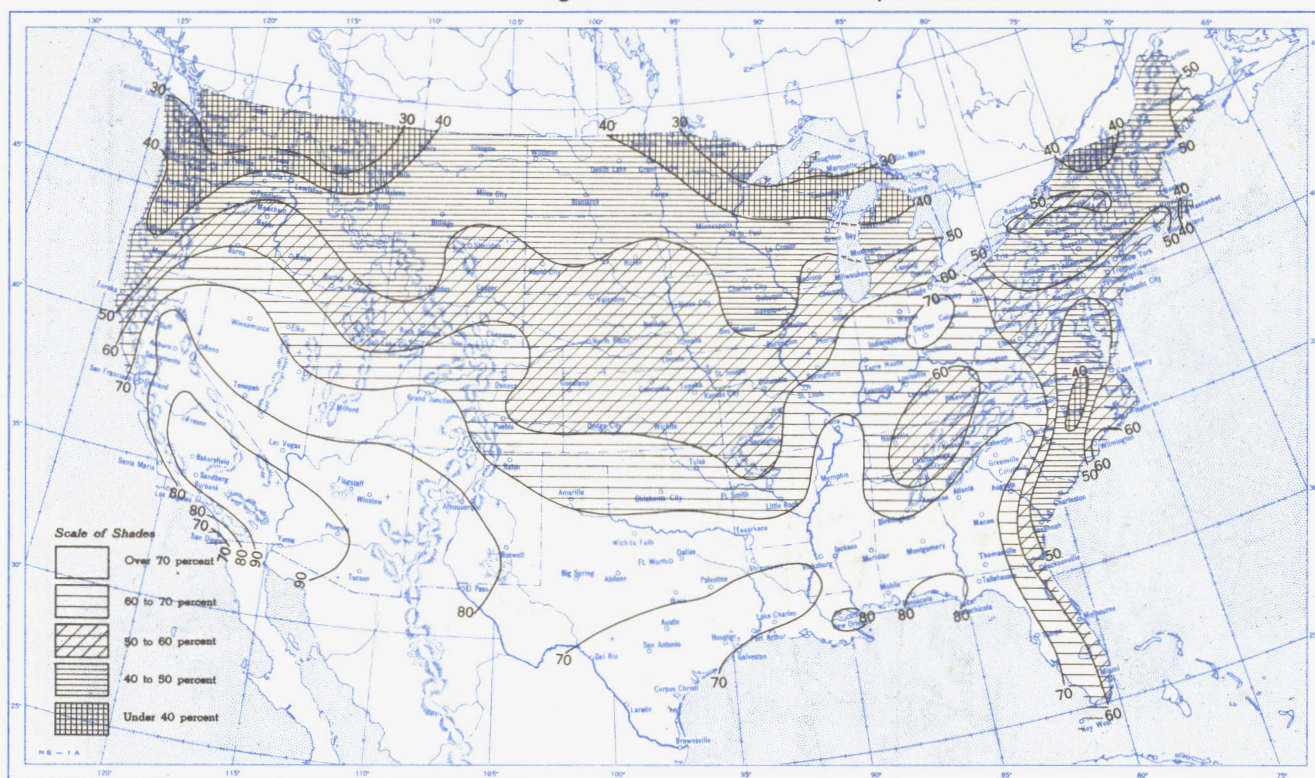


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, October 1951.

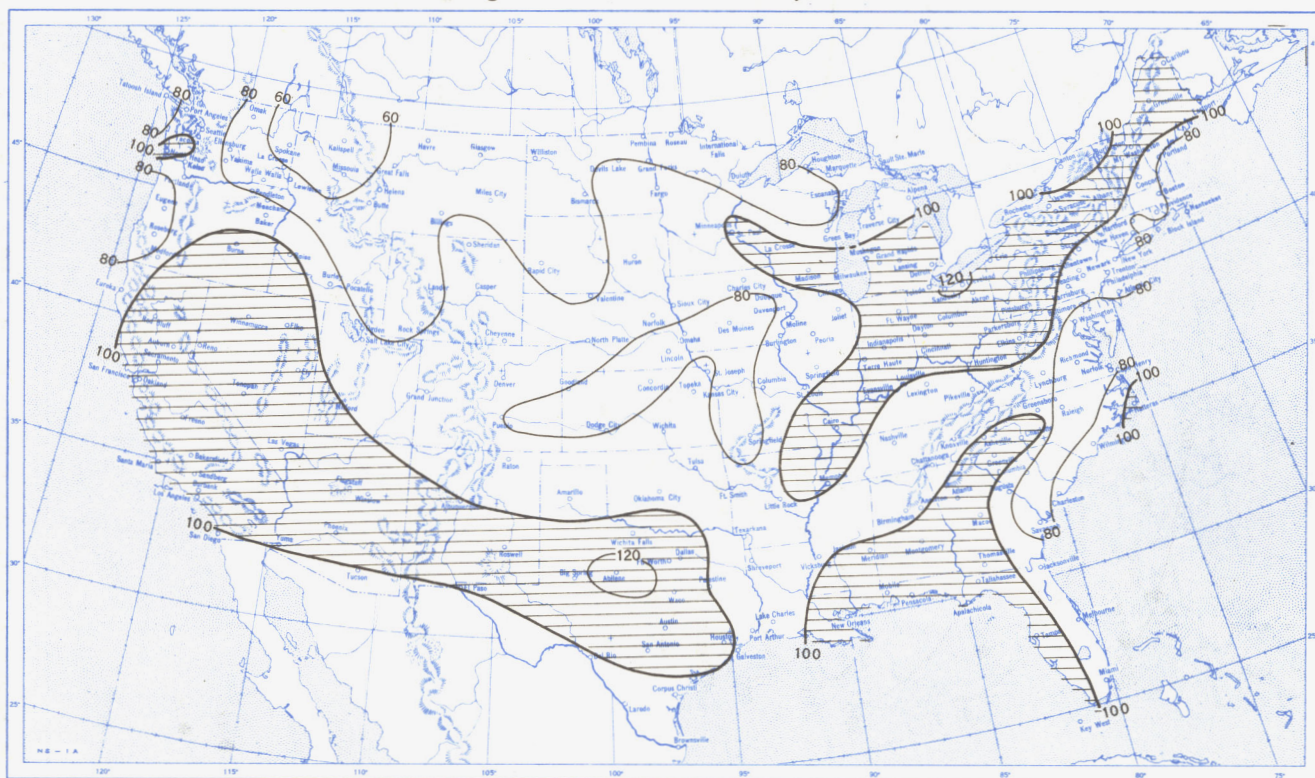


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, October 1951.



B. Percentage of Normal Sunshine, October 1951.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, October 1951. Inset: Percentage of Normal Average Daily Solar Radiation, October 1951.

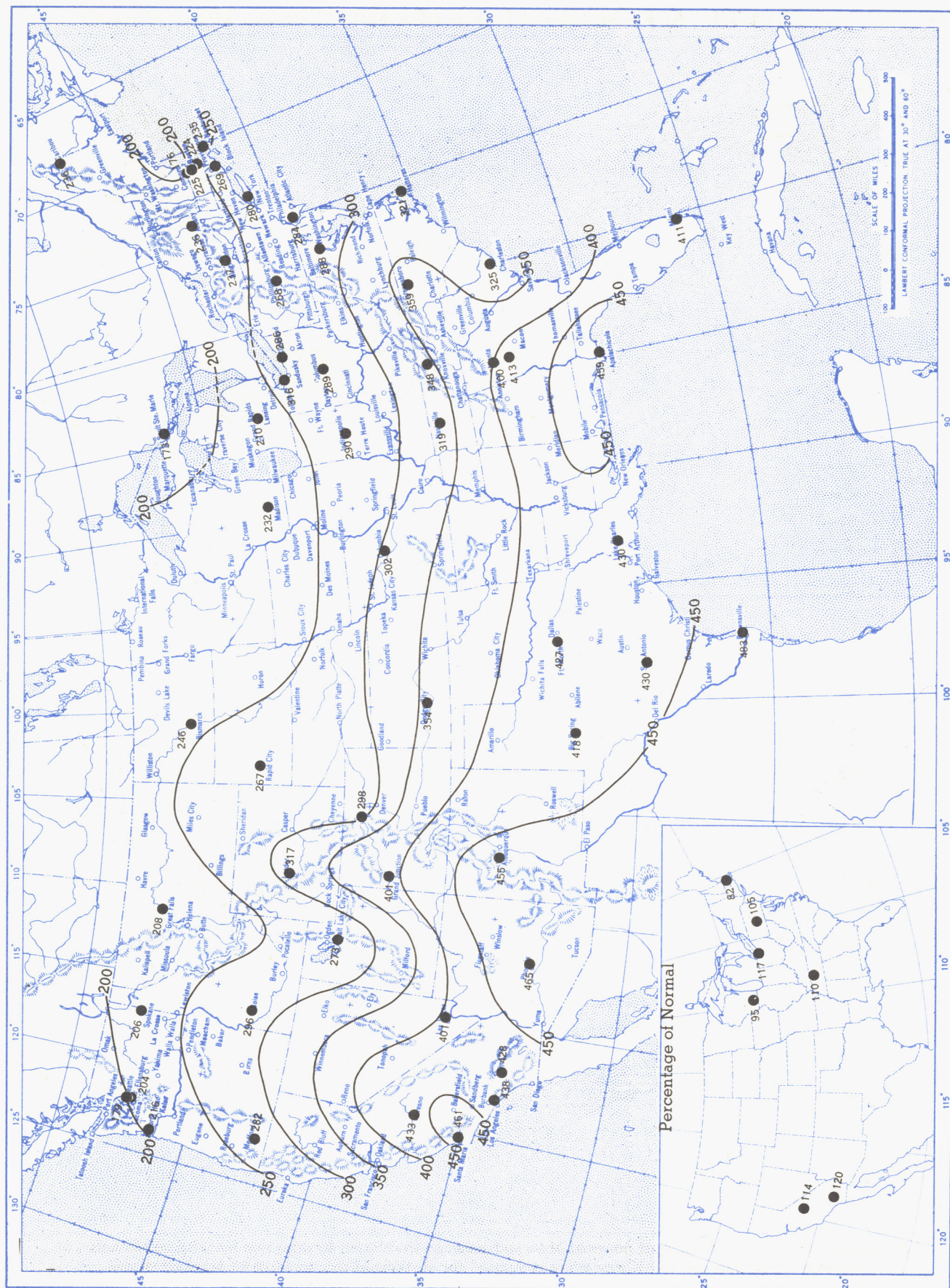
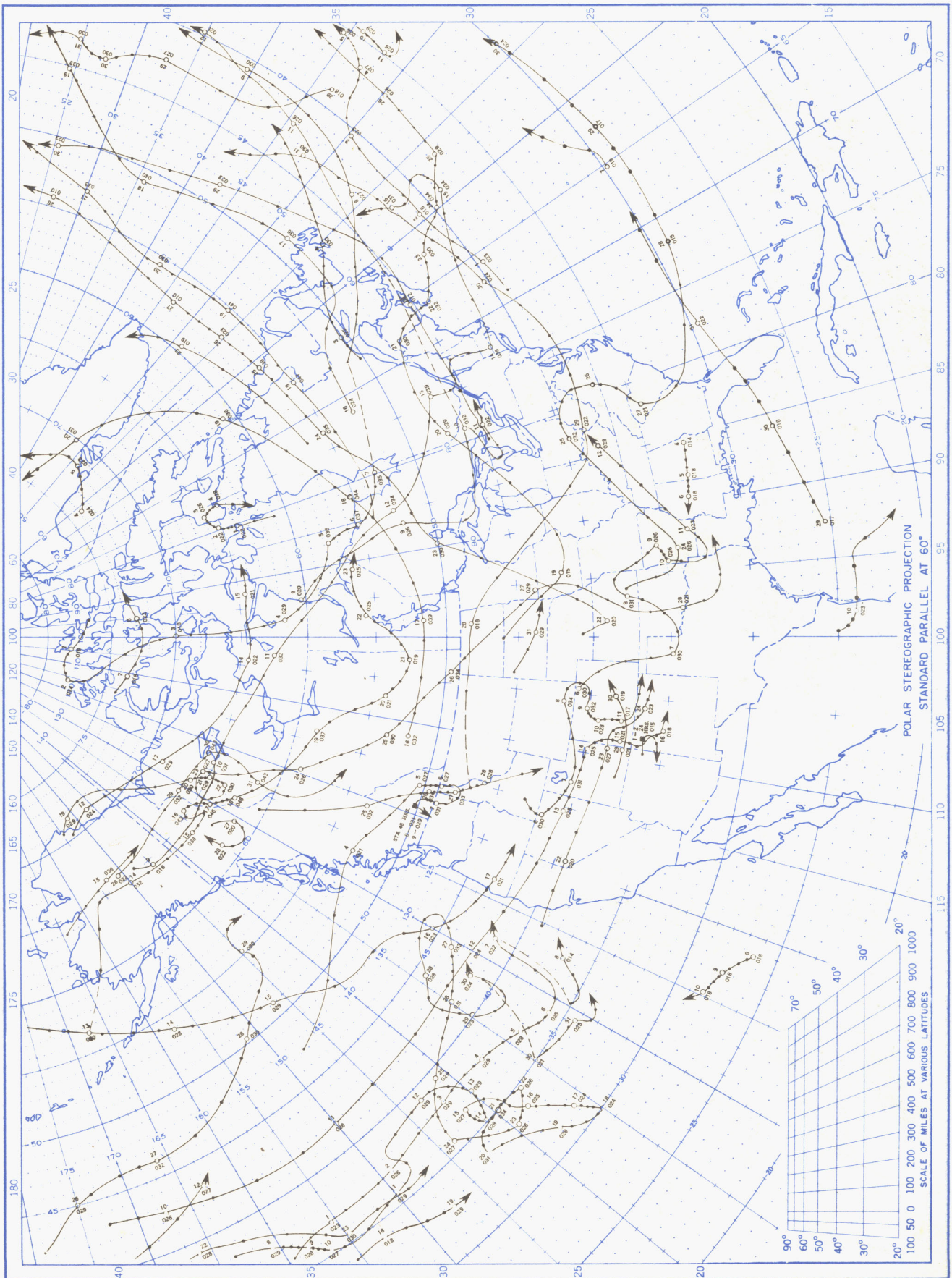


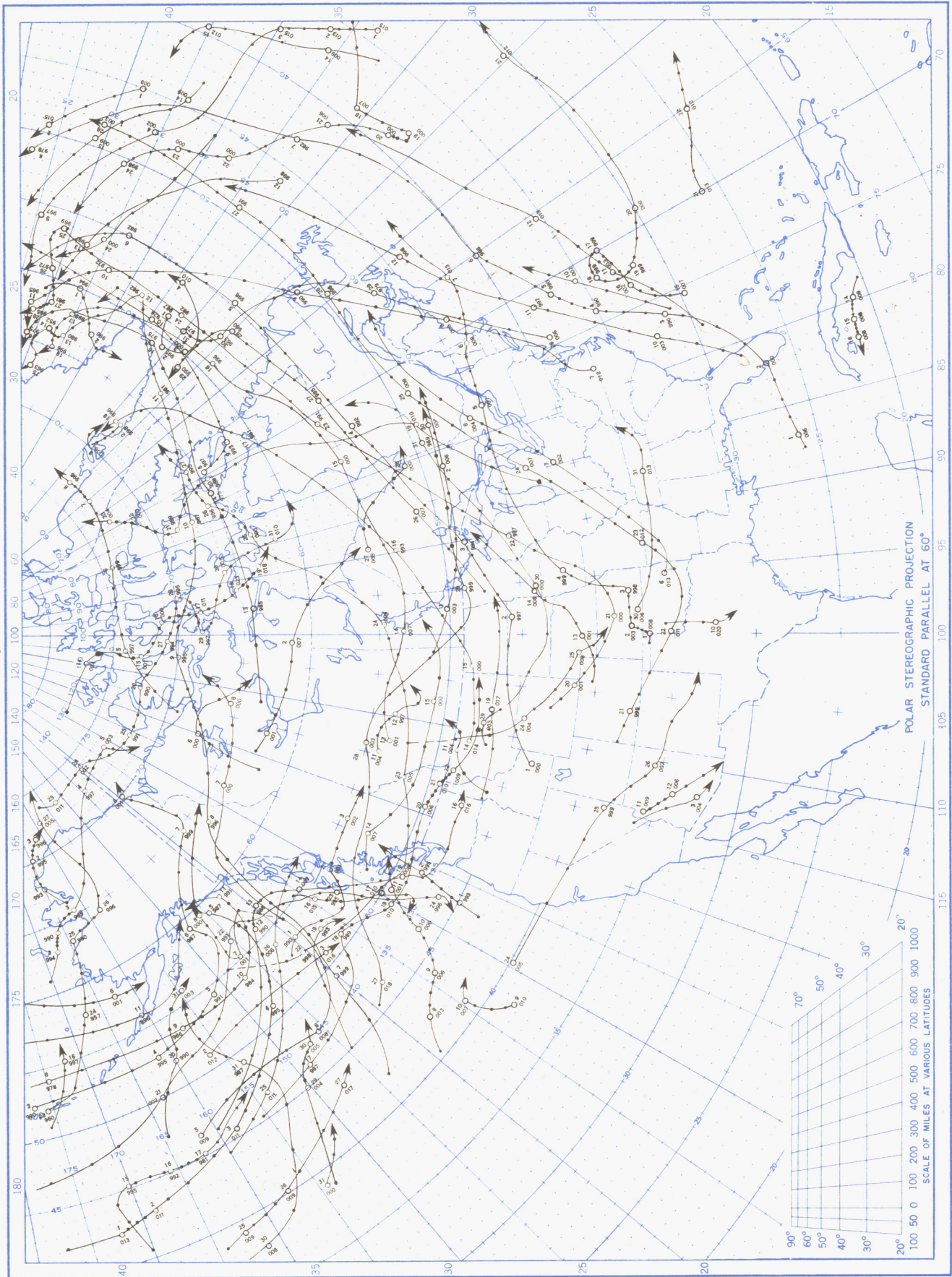
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm. ⁻²). Basic data for isolines are shown on chart. Further estimates obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, October 1951



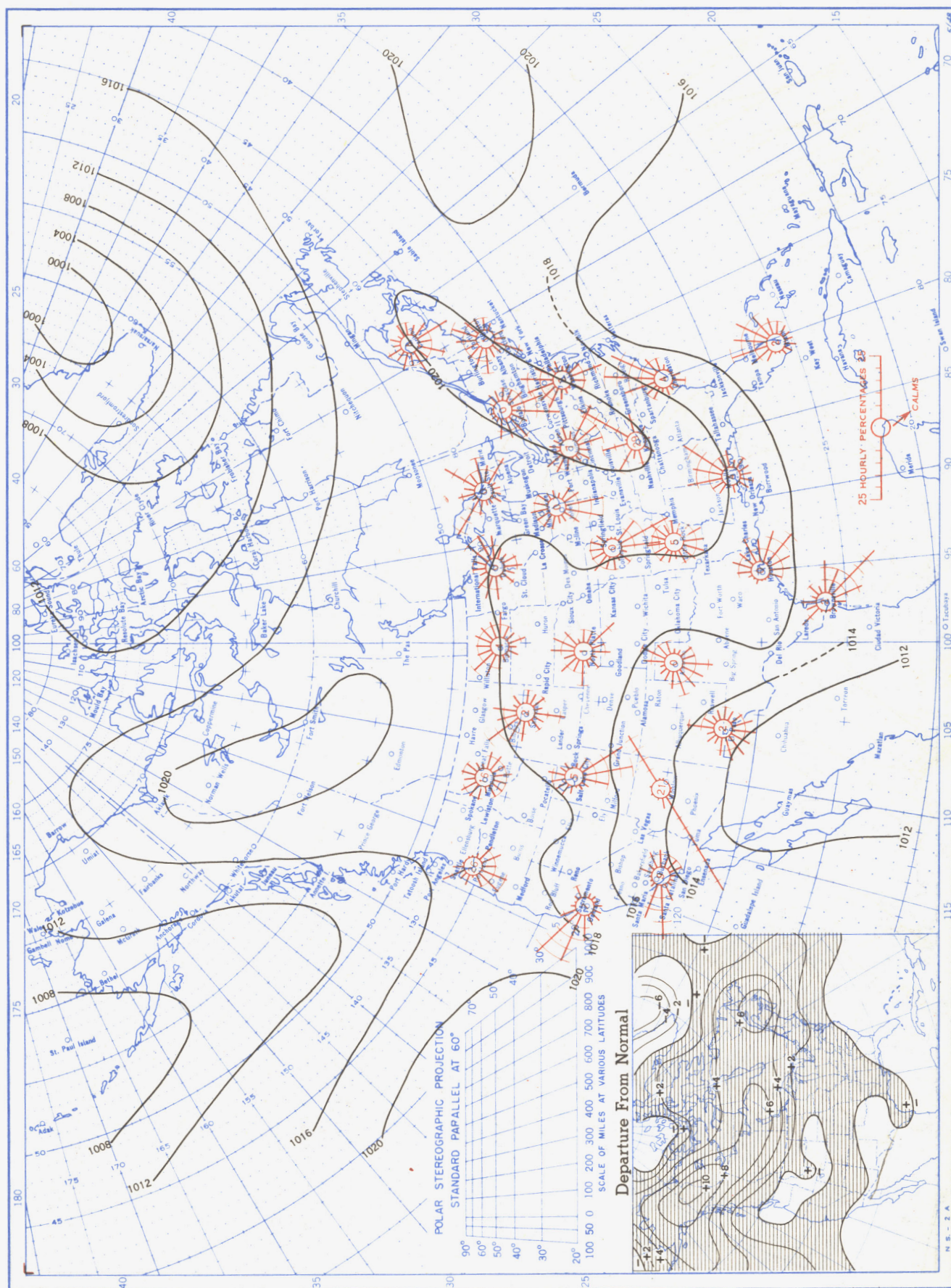
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar.
 Dots indicate intervening 6-hourly positions.
 Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, October 1951.



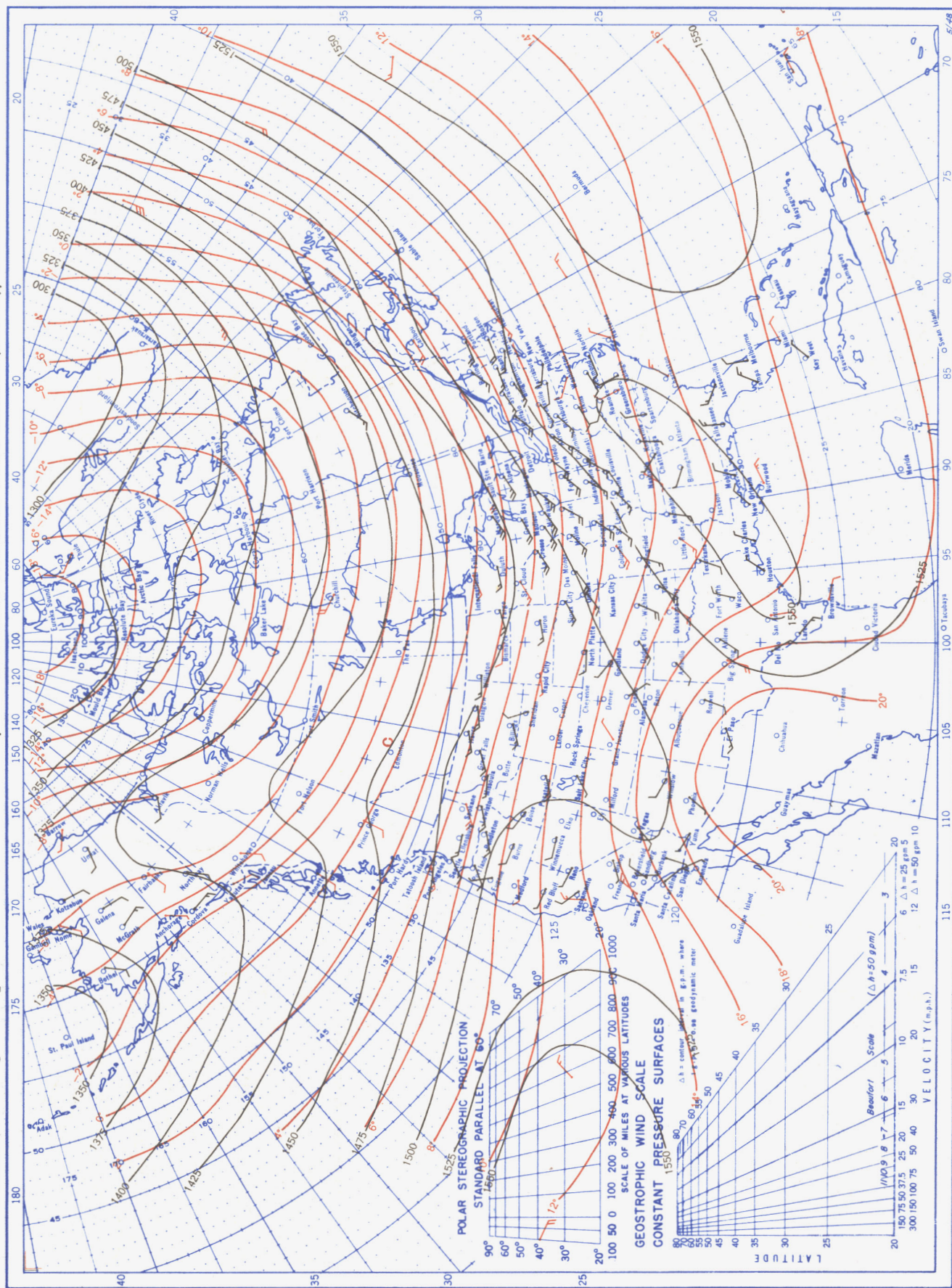
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, October 1951. Inset: Departure of Average Pressure (mb.) from Normal, October 1951.



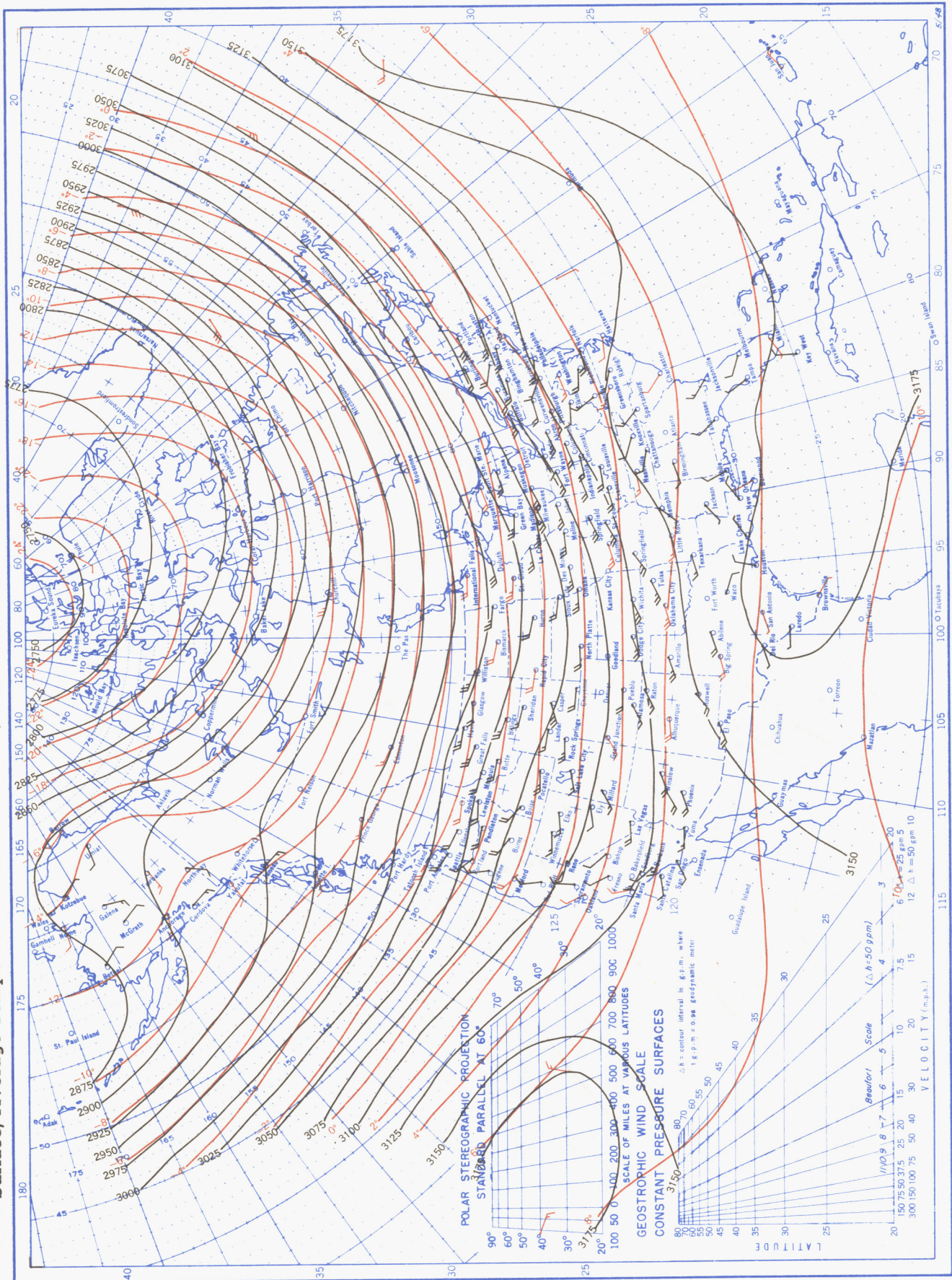
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid from map readings for 20 years of the Historical Weather Maps, 1899-1939.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), October 1951.



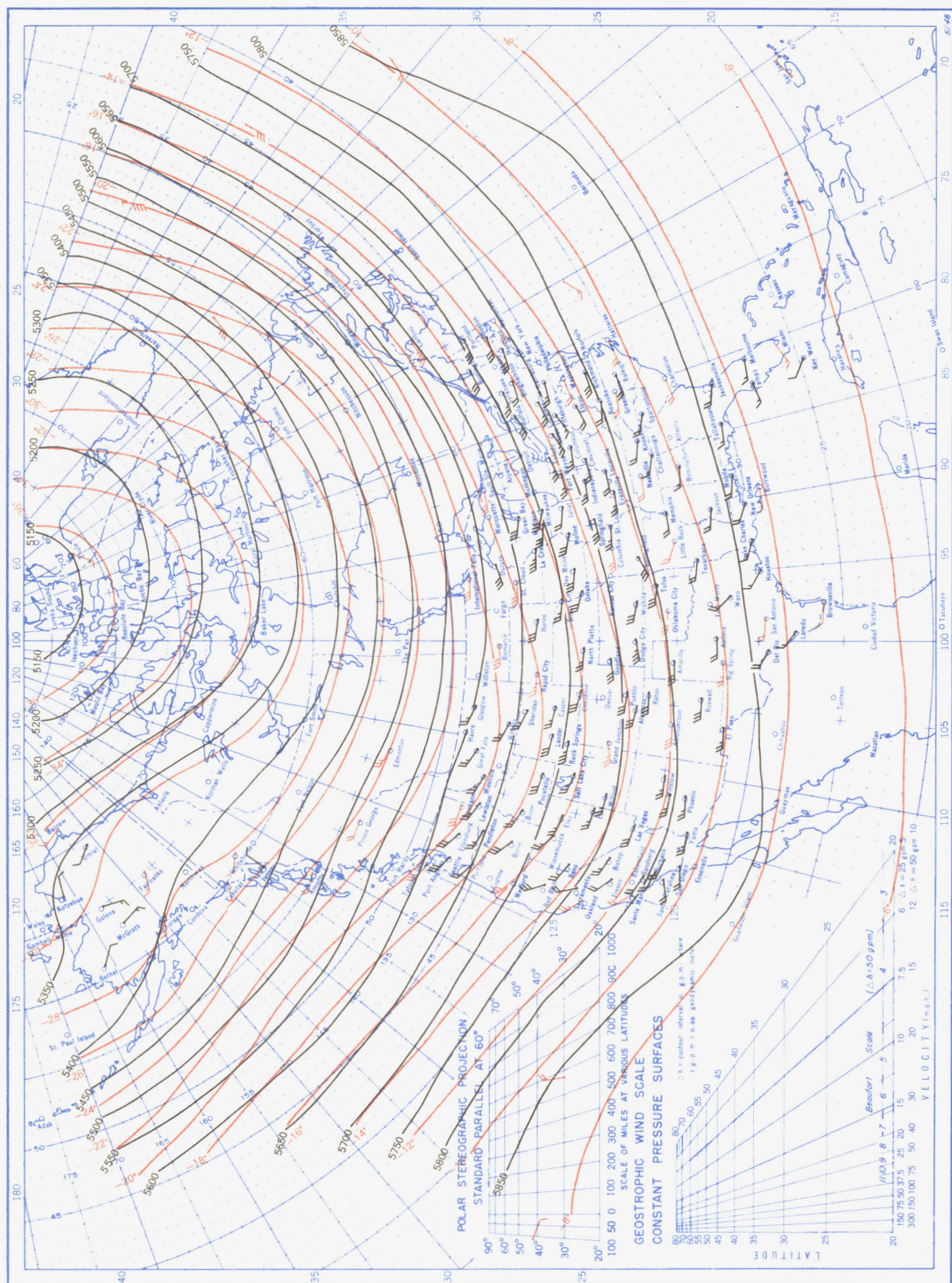
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), October 1951.



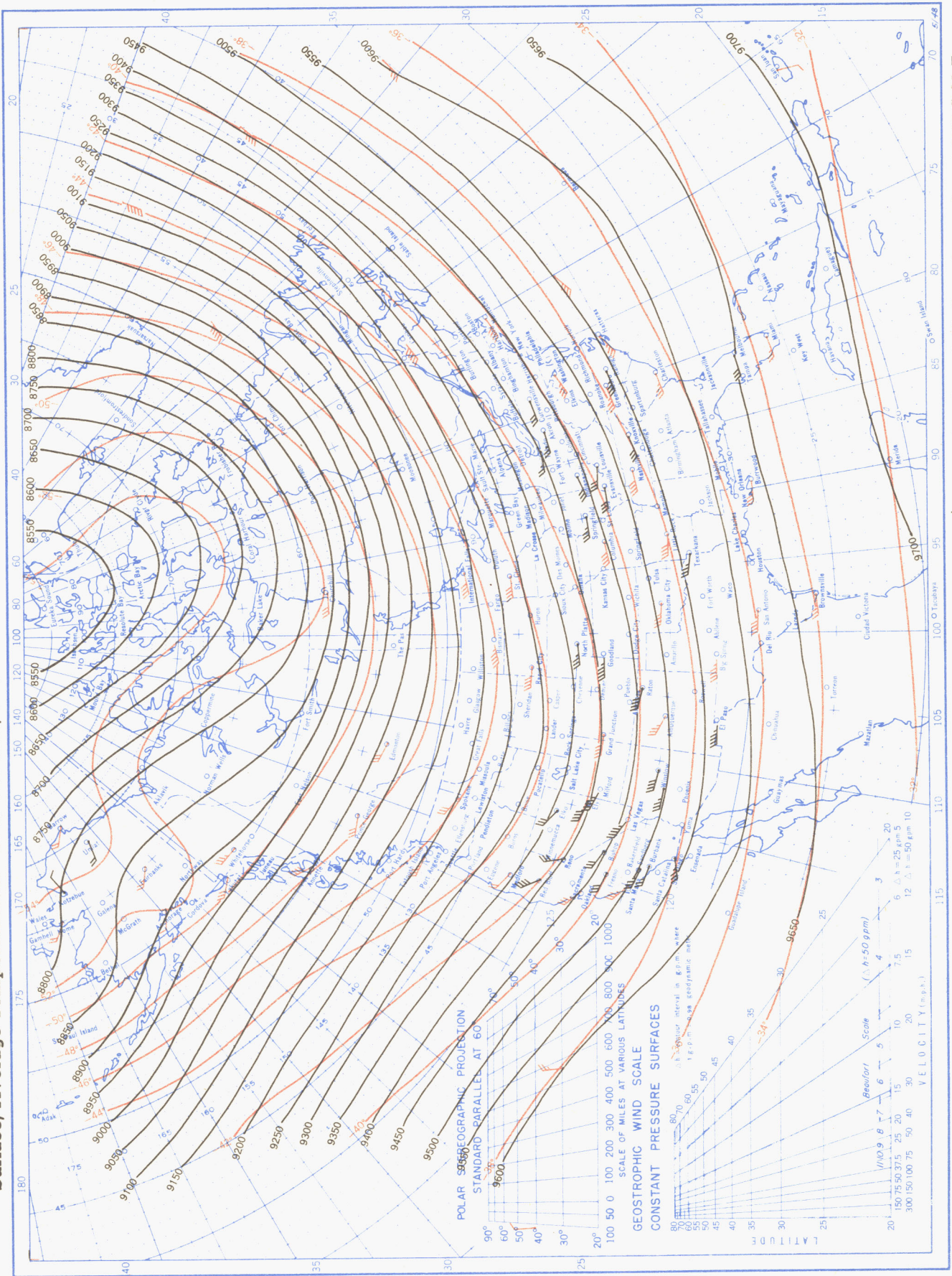
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), October 1951.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), October 1951.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawinsonde observations at 0300 G. M. T.